

Inputs

- [-building inputs \(inventory, levers\)](#)
- [-transportation inputs \(inventory, levers\)](#)
- [other sector inputs](#)

Results

- [All actions](#)
- [Forecast](#)
- [-building emissions](#)
- [-transportation emissions](#)
- [-other emissions \(solid waste, fugitive emissions\)](#)

Building energy background calculations

- [-building energy use](#)
- [-electricity emissions factors](#)
- [building stock \(turnover, code and retrofits\)](#)

Transportation background calculations

- [-EV penetration](#)
- [-VMT](#)
- [-vehicle efficiency](#)

Other

- [Emissions factors](#)
- [PV Area calculations](#)
- [Spreadsheet data flow chart](#)

Inventory Inputs

Residential energy use		
kWh	electric MTCO2e	therms natural gas
1,901,089,585	1,126,002	227,992,102

Commercial energy use		
kWh	electric MTCO2e	therms natural gas
2,500,675,312	1,481,132	91,696,527

Industrial energy use		
kWh	electric MTCO2e	therms natural gas
945,469,790	559,995	182,069,641

Action inputs

1. Residential Weatherization	kWh/home savings	therms/home savings
	1160	185

2. Commercial building benchmarking	% electric/gas savings
	2.4%

3. Building code	Residential	
	% electric savings	% gas savings
	30%	30%

4. Beyond code new buildings	Residential - net zero energy	
	% electric savings	% gas savings
	100%	100%

5. Solar PV - direct contract	PV MW	annual kWh/MW
	100	1532000

6. Clean electricity: Electricity change in emissions intensity (% compared to 2005)		
Year	Reduction in CO2e/kWh	
2018	35%	
2025	60%	
2030	80%	
2050	100%	

7. Building electrification (percent of natural gas load shifted to electric)		
Year	Residential & Commer	Industrial
2018	0%	0%
2025	0%	0%
2030	30%	5%
2035	45%	10%
2040	60%	15%
2045	80%	20%
2050	100%	30%

fuel oil MMBtu	propane MMBtu	square ft	households
211,514	284,698	130,000,000	259,687

fuel oil MMBtu	square ft	commercial growth rate
3,054	174,920,061	0.2%

industrial growth rate
0.2%

homes/year
4000

% of building area
90%

Commercial % electric savings	% gas savings	% of existing buildings/year replaced
20%	20%	1%

Commercial - efficient and electrified			
% of new building area	% electric savings	% gas savings	% of new building area
20%	20%	100%	30%

reflecting approx 500 housing units/year (1% replacement rate ~ 2,500)

Source: Figure 6 of <https://www.wecenergygroup.com/csr/climate-report.pdf>

Electric heating MMbtu/kWh
0.008

Industry Mmbtu/kWh
0.008

Gas heating efficiency
80%



Population growth rate
0.2%

kWh/house therms/household
7,321 878

sq ft/household
501



Inventory data				
Light duty vehicles			Heavy duty vehicles	
VMT	MTCO2e		VMT	MTCO2e
2,807,553,060	1,159,950		311,950,340	457,767

VMT per capita reduction goal	
2030	20%
2040	30%
2050	30%

Efficiency impr
2030
2040
2050

Percent EV - light duty		
Start	0.5%	% of total vehicles
2030	50%	% of new vehicles
2040	90%	% of new vehicles
2050	100%	% of new vehicles
	15	year average vehicle lifetime

Percent EV - heavy duty	
2030	30
2040	80
2050	100

0.78% Wisconsin EV market share in 2018

<https://evadoption.com/ev-market-share/ev-market-share-state/>

Movement from start (non-electric)		
LDV	HDV	
14%	0%	
23%	0%	
23%	0%	

% of new vehicles
% of new vehicles
% of new vehicles

Electric vehicle efficiency (kWh/100 mi)		
Light duty	Heavy duty	
30	200	

Inventory emissions (MTCO ₂ e)		
Solid Waste	Wastewater	Natural gas fugitive
142,149	5,000	87,053

Total emissions, by scenario (MTCO2e). Each column adds to the emissions reductions of the p

Year	BAU	Energy Code	Beyond Code Ne Home Weatheriz	Benchmarking
2018	7,681,898	7,681,898	7,681,898	7,681,898
2019	7,697,262	7,697,262	7,697,262	7,697,262
2020	7,712,657	7,712,657	7,712,657	7,712,657
2021	7,728,082	7,728,082	7,728,082	7,728,082
2022	7,743,538	7,732,355	7,721,443	7,714,639
2023	7,759,025	7,734,423	7,710,415	7,696,808
2024	7,774,543	7,736,517	7,699,410	7,678,999
2025	7,790,092	7,738,637	7,688,427	7,661,212
2026	7,805,672	7,740,785	7,677,466	7,643,447
2027	7,821,284	7,742,958	7,666,528	7,625,705
2028	7,836,926	7,745,159	7,655,611	7,607,985
2029	7,852,600	7,747,386	7,644,717	7,590,287
2030	7,868,305	7,749,641	7,633,846	7,572,611
2031	7,884,042	7,751,922	7,622,997	7,554,959
2032	7,899,810	7,754,230	7,612,170	7,544,132
2033	7,915,610	7,756,565	7,601,366	7,533,328
2034	7,931,441	7,758,927	7,590,585	7,522,547
2035	7,947,304	7,761,316	7,579,826	7,511,788
2036	7,963,198	7,763,732	7,569,090	7,501,052
2037	7,979,125	7,766,175	7,558,377	7,490,338
2038	7,995,083	7,768,646	7,547,686	7,479,648
2039	8,011,073	7,771,144	7,537,018	7,468,980
2040	8,027,095	7,773,669	7,526,373	7,458,335
2041	8,043,150	7,776,222	7,515,751	7,447,713
2042	8,059,236	7,778,802	7,505,152	7,437,114
2043	8,075,354	7,781,410	7,494,576	7,426,537
2044	8,091,505	7,784,045	7,484,023	7,415,984
2045	8,107,688	7,786,708	7,473,493	7,405,454
2046	8,123,903	7,789,399	7,462,986	7,394,947
2047	8,140,151	7,792,118	7,452,502	7,384,464
2048	8,156,432	7,794,864	7,442,042	7,374,003
2049	8,172,744	7,797,638	7,431,604	7,363,566
2050	8,189,090	7,800,440	7,421,190	7,353,152

Impact of action

Year	Energy Code	Beyond Code Ne Home Weatheriz	Benchmarking	100MW solar
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	11183	10912	6804	43191
2023	24602	24007	13608	86555
2024	38026	37107	20412	130093
2025	51455	50210	27215	173804

2026	64888	63318	34019	217689	90739
2027	78325	76431	40823	218125	90739
2028	91767	89548	47627	218561	90739
2029	105214	102669	54431	218998	90739
2030	118665	115795	61235	219436	90739
2031	132120	128925	68038	219875	90739
2032	145581	142059	68038	220315	90739
2033	159045	155198	68038	220755	90739
2034	172514	168342	68038	221197	90739
2035	185988	181489	68038	221639	90739
2036	199467	194642	68038	222082	90739
2037	212950	207799	68038	222526	90739
2038	226437	220960	68038	222972	90739
2039	239929	234126	68038	223417	90739
2040	253426	247296	68038	223864	90739
2041	266928	260471	68038	224312	90739
2042	280434	273650	68038	224761	90739
2043	293944	286834	68038	225210	90739
2044	307460	300023	68038	225661	90739
2045	320980	313216	68038	226112	90739
2046	334504	326413	68038	226564	90739
2047	348034	339615	68038	227017	90739
2048	361568	352822	68038	227471	90739
2049	375107	366033	68038	227926	90739
2050	388650	379249	68038	228382	90739

previous.

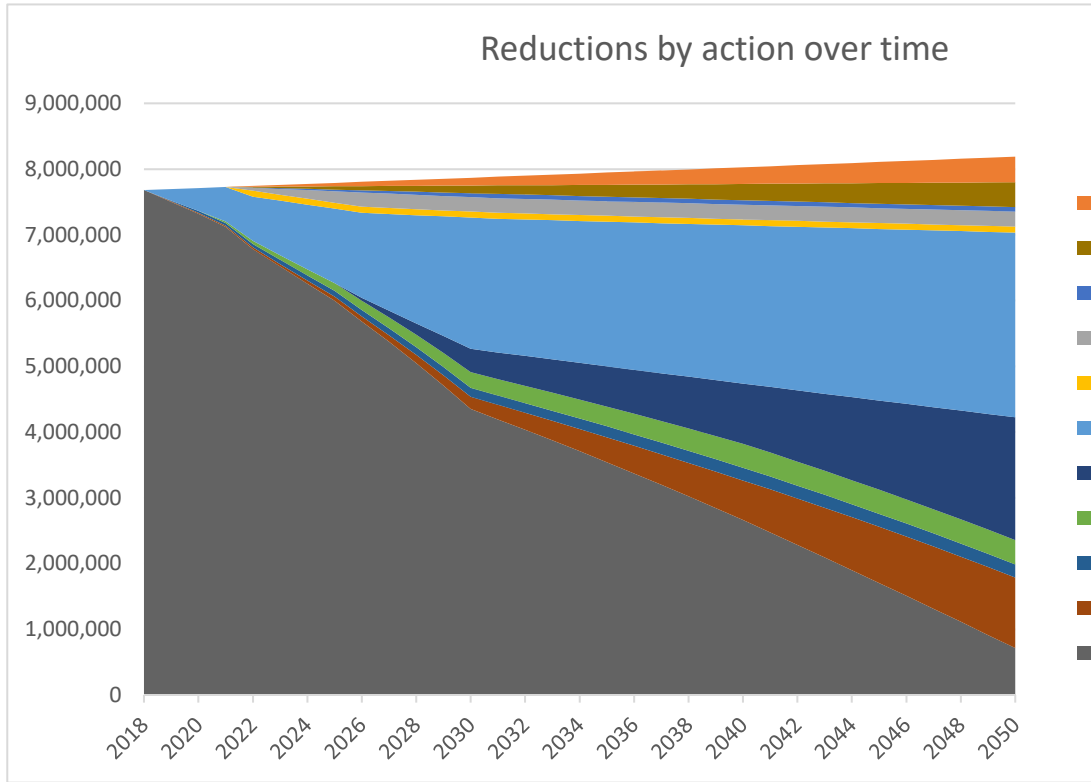
100MW solar	Cleaner Grid	Existing building	VTMT reduction	Vehicle efficiency	Vehicle electrification
7,681,898	7,681,898	7,681,898	7,681,898	7,681,898	7,681,898
7,697,262	7,522,896	7,522,896	7,522,896	7,509,336	7,501,062
7,712,657	7,363,227	7,363,227	7,363,227	7,336,053	7,323,331
7,728,082	7,202,889	7,202,889	7,179,148	7,139,137	7,120,308
7,580,708	6,908,439	6,908,439	6,860,952	6,808,603	6,781,889
7,519,513	6,689,703	6,689,703	6,618,467	6,554,279	6,517,946
7,458,167	6,475,066	6,475,066	6,380,075	6,304,549	6,256,900
7,396,669	6,264,548	6,264,548	6,145,797	6,059,432	5,998,802
7,335,019	6,039,015	5,996,134	5,853,618	5,756,913	5,678,732
7,316,841	5,845,239	5,745,068	5,578,784	5,472,239	5,372,313
7,298,684	5,652,246	5,480,291	5,290,233	5,174,348	5,048,761
7,280,550	5,460,033	5,201,715	4,987,879	4,863,153	4,708,249
7,262,436	5,268,600	4,909,252	4,671,632	4,538,566	4,350,935
7,244,345	5,210,582	4,804,642	4,554,444	4,414,343	4,191,737
7,233,078	5,157,585	4,703,071	4,440,290	4,293,338	4,033,393
7,221,834	5,104,709	4,599,628	4,324,258	4,170,640	3,874,760
7,210,611	5,051,954	4,494,300	4,206,336	4,046,235	3,708,733
7,199,409	4,999,318	4,387,074	4,086,514	3,920,113	3,540,462
7,188,230	4,946,801	4,277,941	3,964,777	3,792,260	3,369,935
7,177,072	4,894,403	4,166,887	3,841,116	3,662,666	3,197,135
7,165,937	4,842,124	4,053,900	3,715,517	3,531,319	3,022,047
7,154,823	4,789,963	3,938,969	3,587,969	3,398,206	2,844,653
7,143,731	4,737,920	3,822,081	3,458,459	3,263,315	2,664,932
7,132,661	4,685,995	3,687,626	3,323,292	3,127,754	2,474,778
7,121,614	4,634,186	3,550,516	3,185,465	2,989,533	2,283,583
7,110,588	4,582,494	3,410,735	3,044,963	2,848,637	2,091,331
7,099,584	4,530,919	3,268,268	2,901,769	2,705,050	1,898,007
7,088,603	4,479,459	3,123,098	2,755,868	2,558,755	1,703,596
7,077,644	4,428,114	2,975,210	2,607,243	2,409,736	1,508,082
7,066,707	4,376,884	2,824,586	2,455,878	2,257,978	1,311,049
7,055,793	4,325,770	2,671,210	2,301,757	2,103,462	1,112,510
7,044,900	4,274,769	2,515,067	2,144,862	1,946,174	912,475
7,034,031	4,223,882	2,356,139	1,985,179	1,786,096	714,210

Cleaner Grid	Existing building	VTMT reduction	Vehicle efficiency	Vehicle electrification	Remaining emissions
0	0	0	0	0	7681898
174366	0	0	13560	8274	7501062
349430	0	0	27174	12722	7323331
525193	0	23741	40011	18829	7120308
672269	0	47486	52349	26714	6781889
829810	0	71237	64188	36333	6517946
983100	0	94991	75526	47648	6256900
1132121	0	118751	86365	60629	5998802

1296003	42882	142515	96705	78181	5678732
1471602	100171	166284	106545	99926	5372313
1646439	171955	190058	115885	125587	5048761
1820516	258318	213836	124726	154904	4708249
1993836	359349	237619	133067	187630	4350935
2033763	405940	250198	140101	222605	4191737
2075493	454514	262782	146951	259945	4033393
2117124	505081	275370	153618	295880	3874760
2158657	557654	287963	160101	337502	3708733
2200092	612243	300561	166401	379650	3540462
2241429	668860	313164	172517	422326	3369935
2282669	727517	325771	178449	465532	3197135
2323812	788224	338383	184198	509272	3022047
2364860	850995	351000	189763	553553	2844653
2405811	915839	363622	195144	598383	2664932
2446666	998369	364334	195538	652976	2474778
2487427	1083671	365051	195932	705950	2283583
2528094	1171759	365772	196325	757306	2091331
2568666	1262651	366499	196719	807043	1898007
2609144	1356360	367230	197113	855159	1703596
2649530	1452904	367966	197507	901654	1508082
2689823	1552299	368708	197901	946928	1311049
2730023	1654559	369454	198294	990953	1112510
2770132	1759702	370205	198688	1033699	912475
2810149	1867743	370960	199082	1071886	714210

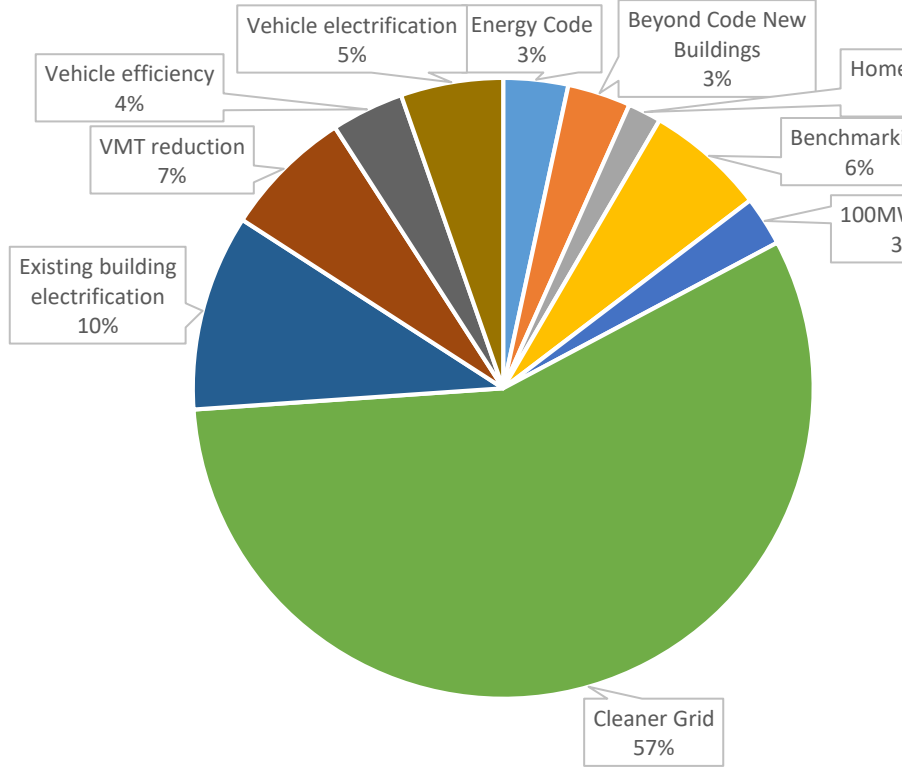
% of 2018

- 100%
- 97%
- 95%
- 92%
- 88%
- 84%
- 80%
- 77%
- 73%
- 69%
- 64%
- 60%
- 55%
- 53%
- 51%
- 49%
- 47%
- 45%
- 42%
- 40%
- 38%
- 36%
- 33%
- 31%
- 28%
- 26%
- 23%
- 21%
- 19%
- 16%
- 14%
- 11%
- 9%



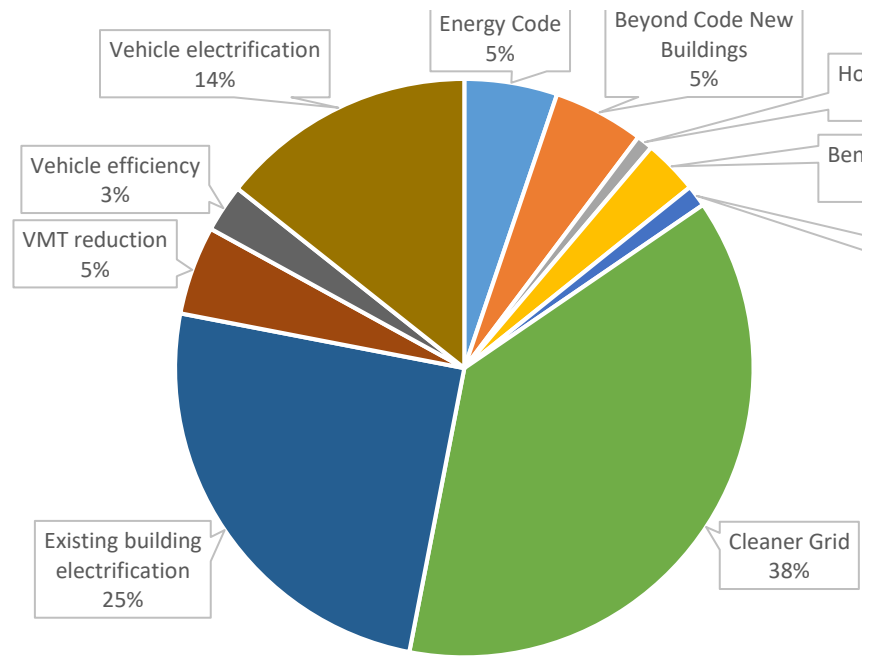
45% by 2030

2030 Emissions reductions by action (% of total reduction)



2050 Emissions reductions by action (% of total reduction)

4,225,044.04



- | Energy Code
- | Beyond Code New Buildings
- | Home Weatherization
- | Benchmarking
- | 100MW solar
- | Cleaner Grid
- | Existing building electrification
- | VMT reduction
- | Vehicle efficiency
- | Vehicle electrification
- | Remaining emissions

ons)

Home Weatherization
2%

ing

W solar
3%

ons)

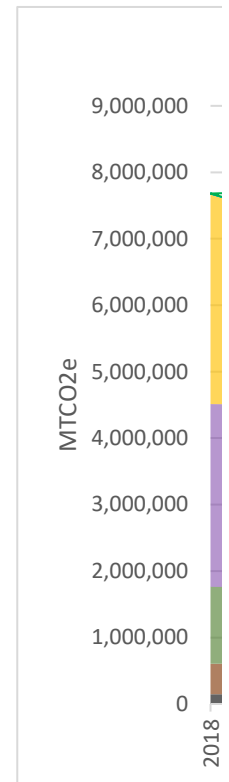
ome Weatherization
1%

enchmarking
3%

100MW solar
1%

Total emissions, by scenario (MTCO2e). Each column adds to the emissions reductions of the p

Year	BAU	Clean Electricity	Vehicle efficiency
2018	7,681,898	7,681,898	7,681,898
2019	7,697,262	7,522,896	7,509,336
2020	7,712,657	7,363,227	7,336,053
2021	7,728,082	7,202,889	7,162,047
2022	7,743,538	7,041,880	6,987,315
2023	7,759,025	6,880,199	6,811,856
2024	7,774,543	6,717,842	6,635,667
2025	7,790,092	6,554,809	6,458,746
2026	7,805,672	6,369,878	6,259,872
2027	7,821,284	6,184,181	6,060,176
2028	7,836,926	5,997,716	5,859,657
2029	7,852,600	5,810,480	5,658,312
2030	7,868,305	5,622,471	5,456,138
2031	7,884,042	5,583,709	5,406,329
2032	7,899,810	5,544,769	5,356,298
2033	7,915,610	5,505,651	5,306,046
2034	7,931,441	5,466,355	5,255,572
2035	7,947,304	5,426,879	5,204,874
2036	7,963,198	5,387,224	5,153,953
2037	7,979,125	5,347,388	5,102,807
2038	7,995,083	5,307,371	5,051,436
2039	8,011,073	5,267,173	4,999,839
2040	8,027,095	5,226,792	4,948,015
2041	8,043,150	5,186,230	4,906,895
2042	8,059,236	5,145,484	4,865,590
2043	8,075,354	5,104,554	4,824,101
2044	8,091,505	5,063,440	4,782,426
2045	8,107,688	5,022,141	4,740,565
2046	8,123,903	4,980,656	4,698,517
2047	8,140,151	4,938,986	4,656,283
2048	8,156,432	4,897,129	4,613,860
2049	8,172,744	4,855,085	4,571,250
2050	8,189,090	4,812,853	4,528,450



45% below 2018:
4,225,044

Impact of action

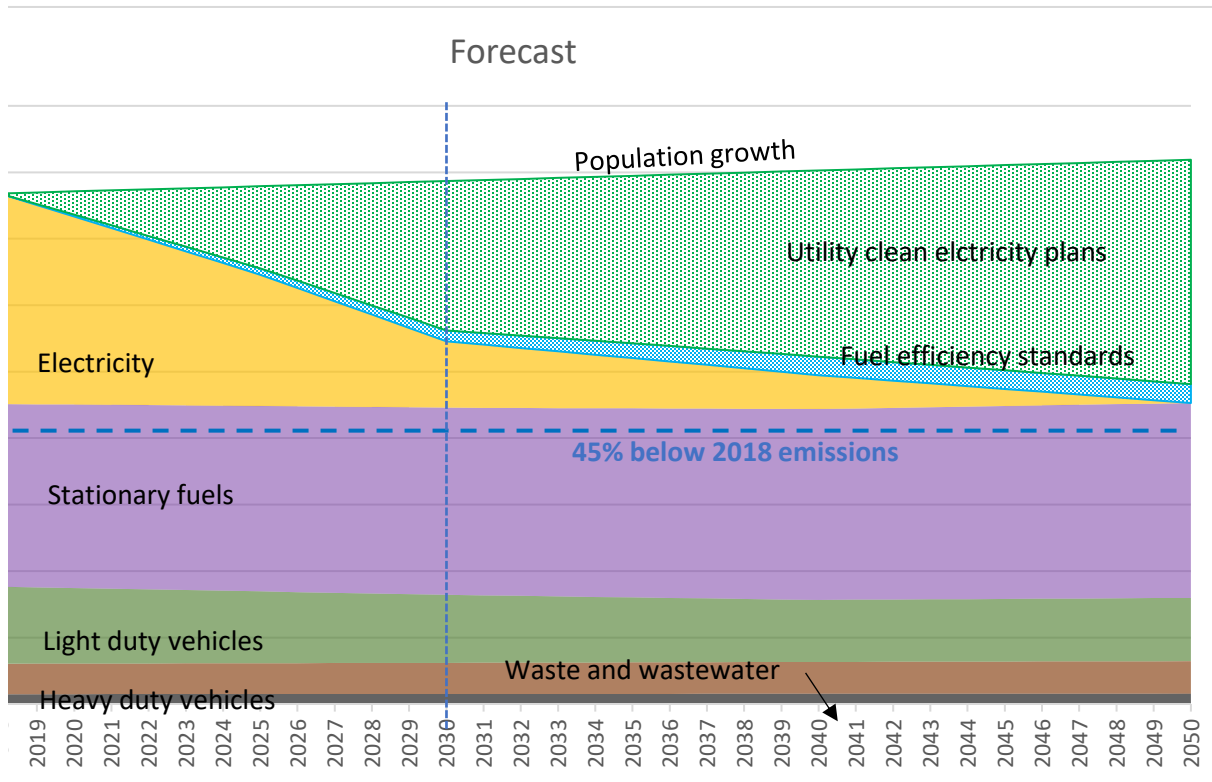
Year	Clean Electricity	Fuel efficiency st	Remainder
2018	0	0	7681898
2019	174366	13560	7509336
2020	349430	27174	7336053
2021	525193	40842	7162047
2022	701658	54565	6987315
2023	878826	68343	6811856
2024	1056701	82176	6635667
2025	1235283	96063	6458746

Remainder by sector

Electricity use	Building fuels
3167130	2749903
2999098	2755403
2830381	2760913
2660977	2766435
2490885	2771968
2320101	2777512
2148625	2783067
1976453	2788633

2026	1435794	110006	6259872	1782365	2794210
2027	1637103	124005	6060176	1587493	2799799
2028	1839210	138059	5859657	1391835	2805398
2029	2042120	152168	5658312	1195387	2811009
2030	2245834	166334	5456138	998148	2816631
2031	2300333	177381	5406329	950137	2822264
2032	2355041	188471	5356298	901931	2827909
2033	2409958	199605	5306046	853527	2833565
2034	2465086	210783	5255572	804926	2839232
2035	2520425	222005	5204874	756127	2844910
2036	2575975	233271	5153953	707130	2850600
2037	2631737	244581	5102807	657934	2856301
2038	2687712	255935	5051436	608539	2862014
2039	2743901	267334	4999839	558943	2867738
2040	2800303	278777	4948015	509146	2873474
2041	2856920	279335	4906895	459148	2879221
2042	2913752	279893	4865590	408948	2884979
2043	2970801	280453	4824101	358545	2890749
2044	3028065	281014	4782426	307939	2896530
2045	3085547	281576	4740565	257129	2902323
2046	3143247	282139	4698517	206115	2908128
2047	3201165	282703	4656283	154895	2913944
2048	3259302	283269	4613860	103470	2919772
2049	3317659	283835	4571250	51838	2925612
2050	3376237	284403	4528450	0	2931463

previous.



2030 with utility plans and fuel efficiency standards

5,456,138

Additional reduction needed in 2030

1,231,094 MTCO₂e

Passenger vehicl	Freight vehicles	Other	total-check
1159950	457767	147149	0
1148710	458683	147443	0
1137421	459600	147738	0
1126081	460519	148034	0
1114692	461440	148330	0
1103253	462363	148626	0
1091763	463288	148924	0
1080224	464214	149221	0

1068633	465143	149520	0
1056992	466073	149819	0
1045300	467005	150119	0
1033558	467939	150419	0
1021763	468875	150720	0
1013093	469813	151021	0
1004383	470752	151323	0
995635	471694	151626	0
986847	472637	151929	0
978021	473583	152233	0
969155	474530	152537	0
960250	475479	152842	0
951305	476430	153148	0
942321	477383	153454	0
933297	478337	153761	0
935164	479294	154069	0
937034	480253	154377	0
938908	481213	154686	0
940786	482176	154995	0
942667	483140	155305	0
944553	484106	155616	0
946442	485074	155927	0
948335	486045	156239	0
950231	487017	156551	0
952132	487991	156864	0

MTCO2e by scenario

Year	BAU	Building code	beyond code new b	Weatherization
2018	5917032	5917032	5917032	5917032
2019	5928866	5928866	5928866	5928866
2020	5940724	5940724	5940724	5940724
2021	5952605	5952605	5952605	5952605
2022	5964511	5953328	5942415	5935611
2023	5976440	5951837	5927830	5914222
2024	5988393	5950366	5913259	5892848
2025	6000369	5948914	5898704	5871489
2026	6012370	5947482	5884164	5850145
2027	6024395	5946070	5869639	5828816
2028	6036444	5944676	5855129	5807502
2029	6048517	5943303	5840634	5786203
2030	6060614	5941949	5826154	5764920
2031	6072735	5940614	5811690	5743651
2032	6084880	5939300	5797241	5729202
2033	6097050	5938005	5782807	5714768
2034	6109244	5936730	5768388	5700350
2035	6121463	5935474	5753985	5685947
2036	6133706	5934239	5739597	5671559
2037	6145973	5933023	5725225	5657186
2038	6158265	5931828	5710868	5642829
2039	6170581	5930652	5696526	5628488
2040	6182923	5929497	5682200	5614162
2041	6195288	5928361	5667890	5599852
2042	6207679	5927245	5653595	5585557
2043	6220094	5926150	5639316	5571277
2044	6232535	5925075	5625052	5557014
2045	6245000	5924020	5610804	5542766
2046	6257490	5922985	5596572	5528534
2047	6270005	5921971	5582355	5514317
2048	6282545	5920977	5568155	5500116
2049	6295110	5920003	5553970	5485931
2050	6307700	5919050	5539800	5471762

Benchmarking	Large scale PV	Clean Electricity	Electrification	Clean electricity with no effi
5917032	5917032	5917032	5917032	5917032
5928866	5928866	5754500	5754500	5754500
5940724	5940724	5591294	5591294	5591294
5952605	5952605	5427413	5427413	5427413
5892420	5801681	5129412	5129412	5262853
5827667	5736928	4907118	4907118	5097613
5762755	5672016	4688916	4688916	4931692
5697685	5606946	4474825	4474825	4765086
5632456	5541716	4245713	4202831	4576576
5610691	5519952	4048350	3948179	4387292
5588941	5498202	3851763	3679809	4197233
5567205	5476466	3655950	3397632	4006397
5545484	5454744	3460909	3101560	3814780
5523777	5433037	3399275	2993335	3772402
5508888	5418148	3342655	2888142	3729840
5494013	5403274	3286150	2781068	3687092
5479153	5388414	3229757	2672103	3644158
5464308	5373568	3173476	2561233	3601038
5449476	5358737	3117308	2448448	3557731
5434660	5343921	3061251	2333735	3514236
5419858	5329119	3005306	2217082	3470553
5405070	5314331	2949472	2098477	3426681
5390298	5299558	2893748	1977909	3382620
5375540	5284800	2838134	1839764	3338368
5360796	5270057	2782629	1698959	3293927
5346067	5255328	2727234	1555475	3249294
5331353	5240614	2671948	1409298	3204469
5316654	5225915	2616770	1260410	3159452
5301969	5211230	2561700	1108796	3114243
5287300	5196561	2506738	954439	3068839
5272645	5181906	2451883	797323	3023242
5258005	5167266	2397134	637432	2977450
5243380	5152641	2342492	474749	2931463

ciency

Calculation of On-road transportation emissions

Light duty vehicles (MTCO₂e)


Year	BAU	VMT reduction	VMT + Fuel efficiency	VMT + FE + EV	efficiency w/ BAU
2018	1,159,950	1,159,950	1,159,950	1,159,950	1,159,950
2019	1,162,270	1,162,270	1,148,710	1,140,617	1,148,710
2020	1,164,594	1,164,594	1,137,421	1,125,345	1,137,421
2021	1,166,924	1,143,183	1,103,171	1,085,841	1,126,081
2022	1,169,257	1,121,771	1,069,422	1,045,549	1,114,692
2023	1,171,596	1,100,359	1,036,172	1,004,618	1,103,253
2024	1,173,939	1,078,948	1,003,421	963,189	1,091,763
2025	1,176,287	1,057,536	971,171	921,400	1,080,224
2026	1,178,640	1,036,124	939,419	876,598	1,068,633
2027	1,180,997	1,014,713	908,168	829,194	1,056,992
2028	1,183,359	993,301	877,416	779,585	1,045,300
2029	1,185,726	971,889	847,164	728,151	1,033,558
2030	1,188,097	950,478	817,411	675,261	1,021,763
2031	1,190,473	940,275	800,174	632,176	1,013,093
2032	1,192,854	930,072	783,121	588,418	1,004,383
2033	1,195,240	919,870	766,252	547,821	995,635
2034	1,197,630	909,667	749,566	503,356	986,847
2035	1,200,026	899,465	733,064	459,628	978,021
2036	1,202,426	889,262	716,745	416,671	969,155
2037	1,204,831	879,060	700,610	374,515	960,250
2038	1,207,240	868,857	684,659	333,190	951,305
2039	1,209,655	858,654	668,892	292,726	942,321
2040	1,212,074	848,452	653,308	253,150	933,297
2041	1,214,498	850,164	654,626	221,432	935,164
2042	1,216,927	851,876	655,945	192,062	937,034
2043	1,219,361	853,589	657,263	165,049	938,908
2044	1,221,800	855,301	658,582	140,403	940,786
2045	1,224,243	857,013	659,900	118,134	942,667
2046	1,226,692	858,725	661,219	98,253	944,553
2047	1,229,145	860,438	662,537	79,614	946,442
2048	1,231,604	862,150	663,855	62,224	948,335
2049	1,234,067	863,862	665,174	46,088	950,231
2050	1,236,535	865,574	666,492	31,212	952,132

Heavy duty vehicles (MTCO2e)			Total (light + heavy duty vehicles)		
BAU	Fuel efficiency	FE + EV	BAU	VMT reduction	VMT + Fuel effici
457,767	457,767	457,767	1,617,717	1,617,717	1,617,717
458,683	458,683	458,501	1,620,952	1,620,952	1,607,393
459,600	459,600	458,954	1,624,194	1,624,194	1,597,020
460,519	460,519	459,021	1,627,443	1,603,702	1,563,690
461,440	461,440	458,599	1,630,698	1,583,211	1,530,862
462,363	462,363	457,584	1,633,959	1,562,722	1,498,535
463,288	463,288	455,872	1,637,227	1,542,235	1,466,709
464,214	464,214	453,356	1,640,501	1,521,750	1,435,385
465,143	465,143	449,784	1,643,782	1,501,267	1,404,562
466,073	466,073	445,121	1,647,070	1,480,786	1,374,241
467,005	467,005	439,249	1,650,364	1,460,306	1,344,421
467,939	467,939	432,047	1,653,665	1,439,829	1,315,103
468,875	468,875	423,395	1,656,972	1,419,353	1,286,286
469,813	469,813	415,206	1,660,286	1,410,088	1,269,987
470,752	470,752	405,510	1,663,607	1,400,825	1,253,873
471,694	471,694	394,245	1,666,934	1,391,564	1,237,946
472,637	472,637	381,345	1,670,268	1,382,305	1,222,203
473,583	473,583	367,368	1,673,608	1,373,047	1,206,646
474,530	474,530	352,279	1,676,955	1,363,792	1,191,275
475,479	475,479	336,043	1,680,309	1,354,538	1,176,089
476,430	476,430	318,627	1,683,670	1,345,287	1,161,089
477,383	477,383	299,995	1,687,037	1,336,037	1,146,274
478,337	478,337	280,113	1,690,411	1,326,789	1,131,645
479,294	479,294	259,512	1,693,792	1,329,458	1,133,920
480,253	480,253	238,185	1,697,180	1,332,129	1,136,197
481,213	481,213	216,121	1,700,574	1,334,802	1,138,476
482,176	482,176	193,311	1,703,975	1,337,476	1,140,757
483,140	483,140	169,747	1,707,383	1,340,153	1,143,040
484,106	484,106	145,418	1,710,798	1,342,832	1,145,325
485,074	485,074	121,069	1,714,220	1,345,512	1,147,611
486,045	486,045	96,723	1,717,648	1,348,194	1,149,900
487,017	487,017	72,403	1,721,083	1,350,879	1,152,191
487,991	487,991	51,385	1,724,526	1,353,565	1,154,483

VMT + FE + EV

1,617,717
1,599,118
1,584,299
1,544,861
1,504,148
1,462,202
1,419,061
1,374,756
1,326,381
1,274,315
1,218,834
1,160,199
1,098,656
1,047,382
993,928
942,066
884,701
826,996
768,949
710,558
651,817
592,721
533,263
480,945
430,247
381,170
333,715
287,881
243,670
200,683
158,947
118,491
82,597

Year	MTCO2e from	MTCO2e from		
	Waste and wastewater	Industrial energy, by scenario		
	BAU	BAU	Efficiency	Efficiency + Clean Electricity
2018	147,149	1,557,834	1,557,834	1,557,834
2019	147,443	1,560,949	1,560,949	1,530,119
2020	147,738	1,564,071	1,564,071	1,502,287
2021	148,034	1,567,199	1,567,199	1,474,338
2022	148,330	1,570,334	1,570,334	1,446,270
2023	148,626	1,573,475	1,573,475	1,418,085
2024	148,924	1,576,622	1,576,622	1,389,781
2025	149,221	1,579,775	1,579,775	1,361,358
2026	149,520	1,582,934	1,582,934	1,329,065
2027	149,819	1,586,100	1,586,100	1,296,636
2028	150,119	1,589,272	1,589,272	1,264,073
2029	150,419	1,592,451	1,592,451	1,231,374
2030	150,720	1,595,636	1,595,636	1,198,539
2031	151,021	1,598,827	1,598,827	1,192,094
2032	151,323	1,602,025	1,602,025	1,185,619
2033	151,626	1,605,229	1,605,229	1,179,113
2034	151,929	1,608,439	1,608,439	1,172,576
2035	152,233	1,611,656	1,611,656	1,166,008
2036	152,537	1,614,879	1,614,879	1,159,409
2037	152,842	1,618,109	1,618,109	1,152,779
2038	153,148	1,621,345	1,621,345	1,146,118
2039	153,454	1,624,588	1,624,588	1,139,426
2040	153,761	1,627,837	1,627,837	1,132,702
2041	154,069	1,631,093	1,631,093	1,125,947
2042	154,377	1,634,355	1,634,355	1,119,161
2043	154,686	1,637,624	1,637,624	1,112,343
2044	154,995	1,640,899	1,640,899	1,105,493
2045	155,305	1,644,181	1,644,181	1,098,611
2046	155,616	1,647,469	1,647,469	1,091,697
2047	155,927	1,650,764	1,650,764	1,084,751
2048	156,239	1,654,066	1,654,066	1,077,773
2049	156,551	1,657,374	1,657,374	1,070,763
2050	156,864	1,660,689	1,660,689	1,063,720



Clean electricity
w/ BAU kWh

1,557,834
1,530,119
1,502,287
1,474,338
1,446,270
1,418,085
1,389,781
1,361,358
1,329,065
1,296,636
1,264,073
1,231,374
1,198,539
1,192,094
1,185,619
1,179,113
1,172,576
1,166,008
1,159,409
1,152,779
1,146,118
1,139,426
1,132,702
1,125,947
1,119,161
1,112,343
1,105,493
1,098,611
1,091,697
1,084,751
1,077,773
1,070,763
1,063,720

Start values from inventory

kWh	MTCO2e	MTCO2e/kWh
1901089585	1126002	0.00059229

This section not used - Emissions factor calculated as percent reduction

Year	Generation mix				
	Renewables	Hydro	Nuclear	Coal	Natural gas
2018		35%	0%	0%	65%
2019		39%	0%	0%	61%
2020		42%	0%	0%	58%
2021		46%	0%	0%	54%
2022		49%	0%	0%	51%
2023		53%	0%	0%	47%
2024		56%	0%	0%	44%
2025		60%	0%	0%	40%
2026		68%	0%	0%	32%
2027		76%	0%	0%	24%
2028		84%	0%	0%	16%
2029		92%	0%	0%	8%
2030		100%	0%	0%	0%
2031		80%	0%	0%	20%
2032		60%	0%	0%	40%
2033		40%	0%	0%	60%
2034		20%	0%	0%	80%
2035		0%	0%	0%	100%
2036		0%	0%	0%	100%
2037		0%	0%	0%	100%
2038		0%	0%	0%	100%
2039		0%	0%	0%	100%
2040		0%	0%	0%	100%
2041		0%	0%	0%	100%
2042		0%	0%	0%	100%
2043		0%	0%	0%	100%
2044		0%	0%	0%	100%
2045		0%	0%	0%	100%
2046		0%	0%	0%	100%
2047		0%	0%	0%	100%
2048		0%	0%	0%	100%
2049		0%	0%	0%	100%
2050		0%	0%	0%	100%

MTCO₂e/kWh by generation source

h

Coal	Natural gas
0.000994	0.000420

Predicted MTCO ₂ e/kwh	Emissions factor index (compared to start year)	
	MTCO ₂ e-adjusted to match start year	
0.000273	1	0.000592
0.000258	0.95	0.00056
0.000243	0.89	0.000527
0.000228	0.84	0.000495
0.000213	0.78	0.000462
0.000198	0.73	0.00043
0.000183	0.67	0.000397
0.000168	0.62	0.000364
0.000134	0.55	0.000328
0.000101	0.49	0.000292
0.000067	0.43	0.000255
0.000034	0.37	0.000219
0.000000	0.31	0.000182
0.000084	0.29	0.000173
0.000168	0.28	0.000164
0.000252	0.26	0.000155
0.000336	0.25	0.000146
0.000420	0.23	0.000137
0.000420	0.22	0.000128
0.000420	0.20	0.000118
0.000420	0.18	0.000109
0.000420	0.17	0.0001
0.000420	0.15	9.11E-05
0.000420	0.14	8.2E-05
0.000420	0.12	7.29E-05
0.000420	0.11	6.38E-05
0.000420	0.09	5.47E-05
0.000420	0.08	4.56E-05
0.000420	0.06	3.64E-05
0.000420	0.05	2.73E-05
0.000420	0.03	1.82E-05
0.000420	0.02	9.11E-06
0.000420	0.00	0

Industrial Electricity kWh by scenario

Year	Efficiency	Electrification	Industrial Electricity kWh by scenario			
	index	index	BAU	Efficiency	Eff + electrification	
2018	1.00	1	945,469,790	945,469,790	945,469,790	
2019	1.00	1.00	947,360,730	947,360,730	947,360,730	
2020	1.00	1.00	949,255,451	949,255,451	949,255,451	
2021	1.00	1.00	951,153,962	951,153,962	951,153,962	
2022	1.00	1.00	953,056,270	953,056,270	953,056,270	
2023	1.00	1.00	954,962,382	954,962,382	954,962,382	
2024	1.00	1.00	956,872,307	956,872,307	956,872,307	
2025	1.00	100%	958,786,052	958,786,052	958,786,052	
2026	1.00	0.99	960,703,624	960,703,624	979,203,947	
2027	1.00	0.98	962,625,031	962,625,031	999,699,678	
2028	1.00	0.97	964,550,281	964,550,281	1,020,273,476	
2029	1.00	0.96	966,479,382	966,479,382	1,040,925,570	
2030	1.00	95%	968,412,341	968,412,341	1,061,656,191	
2031	1.00	0.94	970,349,165	970,349,165	1,082,465,571	
2032	1.00	0.93	972,289,864	972,289,864	1,103,353,942	
2033	1.00	0.92	974,234,443	974,234,443	1,124,321,536	
2034	1.00	0.91	976,182,912	976,182,912	1,145,368,588	
2035	1.00	90%	978,135,278	978,135,278	1,166,495,330	
2036	1.00	0.89	980,091,549	980,091,549	1,187,701,998	
2037	1.00	0.88	982,051,732	982,051,732	1,208,988,827	
2038	1.00	0.87	984,015,835	984,015,835	1,230,356,052	
2039	1.00	0.86	985,983,867	985,983,867	1,251,803,910	
2040	1.00	85%	987,955,834	987,955,834	1,273,332,638	
2041	1.00	0.84	989,931,746	989,931,746	1,294,942,473	
2042	1.00	0.83	991,911,610	991,911,610	1,316,633,655	
2043	1.00	0.82	993,895,433	993,895,433	1,338,406,422	
2044	1.00	0.81	995,883,224	995,883,224	1,360,261,013	
2045	1.00	80%	997,874,990	997,874,990	1,382,197,669	
2046	1.00	0.78	999,870,740	999,870,740	1,423,471,197	
2047	1.00	0.76	1,001,870,482	1,001,870,482	1,464,904,290	
2048	1.00	0.74	1,003,874,223	1,003,874,223	1,506,497,421	
2049	1.00	0.72	1,005,881,971	1,005,881,971	1,548,251,066	
2050	1.00	70%	1,007,893,735	1,007,893,735	1,590,165,699	

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Industrial therms by scenario

BAU	Efficiency	Eff + electrification
182,069,641	182,069,641	182,069,641
182,433,780	182,433,780	182,433,780
182,798,648	182,798,648	182,798,648
183,164,245	183,164,245	183,164,245
183,530,574	183,530,574	183,530,574
183,897,635	183,897,635	183,897,635
184,265,430	184,265,430	184,265,430
184,633,961	184,633,961	184,633,961
185,003,229	185,003,229	183,153,197
185,373,235	185,373,235	181,665,771
185,743,982	185,743,982	180,171,662
186,115,470	186,115,470	178,670,851
186,487,701	186,487,701	177,163,316
186,860,676	186,860,676	175,649,035
187,234,397	187,234,397	174,127,990
187,608,866	187,608,866	172,600,157
187,984,084	187,984,084	171,065,516
188,360,052	188,360,052	169,524,047
188,736,772	188,736,772	167,975,727
189,114,246	189,114,246	166,420,536
189,492,474	189,492,474	164,858,453
189,871,459	189,871,459	163,289,455
190,251,202	190,251,202	161,713,522
190,631,705	190,631,705	160,130,632
191,012,968	191,012,968	158,540,763
191,394,994	191,394,994	156,943,895
191,777,784	191,777,784	155,340,005
192,161,339	192,161,339	153,729,072
192,545,662	192,545,662	150,185,616
192,930,753	192,930,753	146,627,373
193,316,615	193,316,615	143,054,295
193,703,248	193,703,248	139,466,339
194,090,655	194,090,655	135,863,458

Modeling of building energy use by action scenario

Year	Res + Com Electricity kWh by scenario (each column includes previous actions)			
	BAU	Building code	Beyond code new	Weatherization
2018	4,401,764,897	4,401,764,897	4,401,764,897	4,401,764,897
2019	4,410,568,427	4,410,568,427	4,410,568,427	4,410,568,427
2020	4,419,389,564	4,419,389,564	4,419,389,564	4,419,389,564
2021	4,428,228,343	4,428,228,343	4,428,228,343	4,428,228,343
2022	4,437,084,799	4,426,294,286	4,423,611,404	4,418,971,404
2023	4,445,958,969	4,422,219,839	4,416,317,500	4,407,037,500
2024	4,454,850,887	4,418,158,825	4,409,035,954	4,395,115,954
2025	4,463,760,589	4,414,111,269	4,401,766,792	4,383,206,792
2026	4,472,688,110	4,410,077,199	4,394,510,039	4,371,310,039
2027	4,481,633,486	4,406,056,643	4,387,265,718	4,359,425,718
2028	4,490,596,753	4,402,049,626	4,380,033,856	4,347,553,856
2029	4,499,577,947	4,398,056,176	4,372,814,478	4,335,694,478
2030	4,508,577,103	4,394,076,320	4,365,607,607	4,323,847,607
2031	4,517,594,257	4,390,110,086	4,358,413,269	4,312,013,269
2032	4,526,629,445	4,386,157,500	4,351,231,489	4,304,831,489
2033	4,535,682,704	4,382,218,590	4,344,062,292	4,297,662,292
2034	4,544,754,070	4,378,293,383	4,336,905,704	4,290,505,704
2035	4,553,843,578	4,374,381,907	4,329,761,750	4,283,361,750
2036	4,562,951,265	4,370,484,189	4,322,630,454	4,276,230,454
2037	4,572,077,167	4,366,600,256	4,315,511,843	4,269,111,843
2038	4,581,221,322	4,362,730,137	4,308,405,941	4,262,005,941
2039	4,590,383,764	4,358,873,858	4,301,312,774	4,254,912,774
2040	4,599,564,532	4,355,031,448	4,294,232,367	4,247,832,367
2041	4,608,763,661	4,351,202,934	4,287,164,747	4,240,764,747
2042	4,617,981,188	4,347,388,344	4,280,109,938	4,233,709,938
2043	4,627,217,151	4,343,587,706	4,273,067,966	4,226,667,966
2044	4,636,471,585	4,339,801,048	4,266,038,857	4,219,638,857
2045	4,645,744,528	4,336,028,397	4,259,022,637	4,212,622,637
2046	4,655,036,017	4,332,269,783	4,252,019,331	4,205,619,331
2047	4,664,346,089	4,328,525,232	4,245,028,965	4,198,628,965
2048	4,673,674,781	4,324,794,772	4,238,051,566	4,191,651,566
2049	4,683,022,131	4,321,078,433	4,231,087,158	4,184,687,158
2050	4,692,388,175	4,317,376,243	4,224,135,768	4,177,735,768

kWh to replace therm of res/com natural gas

10

			Res + com natural gas therms by scen	
Benchmarking	Large-scale solar	Electrification	BAU	Building code
4,401,764,897	4,401,764,897	4,401,764,897	319,688,629	319,688,629
4,410,568,427	4,410,568,427	4,410,568,427	320,328,006	320,328,006
4,419,389,564	4,419,389,564	4,419,389,564	320,968,662	320,968,662
4,428,228,343	4,428,228,343	4,428,228,343	321,610,600	321,610,600
4,364,523,403	4,211,323,403	4,211,323,403	322,253,821	321,379,492
4,297,923,705	4,144,723,705	4,144,723,705	322,898,328	320,974,804
4,231,117,920	4,077,917,920	4,077,917,920	323,544,125	320,571,056
4,164,105,419	4,010,905,419	4,010,905,419	324,191,213	320,168,249
4,096,885,569	3,943,685,569	4,138,589,326	324,839,596	319,766,385
4,084,452,399	3,931,252,399	4,321,839,529	325,489,275	319,365,467
4,072,030,591	3,918,830,591	4,505,883,047	326,140,254	318,965,494
4,059,620,165	3,906,420,165	4,690,722,247	326,792,534	318,566,471
4,047,221,146	3,894,021,146	4,876,359,503	327,446,119	318,168,398
4,034,833,555	3,881,633,555	4,964,366,892	328,101,011	317,771,278
4,027,097,416	3,873,897,416	5,057,423,384	328,757,213	317,375,112
4,019,372,751	3,866,172,751	5,150,890,189	329,414,728	316,979,903
4,011,659,584	3,858,459,584	5,244,768,524	330,073,557	316,585,651
4,003,957,937	3,850,757,937	5,339,059,607	330,733,704	316,192,360
3,996,267,834	3,843,067,834	5,433,764,658	331,395,172	315,800,031
3,988,589,297	3,835,389,297	5,528,884,904	332,057,962	315,408,666
3,980,922,350	3,827,722,350	5,624,421,571	332,722,078	315,018,267
3,973,267,016	3,820,067,016	5,720,375,892	333,387,522	314,628,836
3,965,623,318	3,812,423,318	5,816,749,101	334,054,297	314,240,374
3,957,991,280	3,804,791,280	5,947,014,677	334,722,406	313,852,884
3,950,370,924	3,797,170,924	6,077,835,508	335,391,851	313,466,368
3,942,762,274	3,789,562,274	6,209,213,241	336,062,634	313,080,828
3,935,165,354	3,781,965,354	6,341,149,527	336,734,760	312,696,265
3,927,580,186	3,774,380,186	6,473,646,019	337,408,229	312,312,682
3,920,006,796	3,766,806,796	6,606,704,378	338,083,046	311,930,080
3,912,445,205	3,759,245,205	6,740,326,267	338,759,212	311,548,462
3,904,895,437	3,751,695,437	6,874,513,354	339,436,730	311,167,829
3,897,357,517	3,744,157,517	7,009,267,312	340,115,604	310,788,183
3,889,831,468	3,736,631,468	7,144,589,816	340,795,835	310,409,527

Scenario (each column includes previous actions)

beyond code	Weatherization	Benchmarking	Electrification	
319,688,629	319,688,629	319,688,629	319,688,629	
320,328,006	320,328,006	320,328,006	320,328,006	
320,968,662	320,968,662	320,968,662	320,968,662	
321,610,600	321,610,600	321,610,600	321,610,600	
319,678,309	318,938,308.71	316,941,771	316,941,771	Actions start in 2022
317,232,202	315,752,201.84	311,751,140	311,751,140	
314,786,354	312,566,353.79	306,552,758	306,552,758	
312,340,765	309,380,765.06	301,346,601	301,346,601	
309,895,436	306,195,436.19	296,132,646	276,642,270	
307,450,368	303,010,367.67	292,927,452	253,868,739	
305,005,560	299,825,560.05	289,722,479	231,017,233	
302,561,014	296,641,013.83	286,517,726	208,087,518	
300,116,730	293,456,729.55	283,313,195	185,079,360	
297,672,708	290,272,708	280,108,886	171,835,553	
295,228,949	287,828,949	277,644,800	159,292,203	
292,785,454	285,385,454	275,180,936	146,709,192	
290,342,222	282,942,222	272,717,296	134,086,402	
287,899,255	280,499,255	270,253,879	121,423,712	
285,456,554	278,056,554	267,790,687	108,721,004	
283,014,118	275,614,118	265,327,719	95,978,158	
280,571,948	273,171,948	262,864,976	83,195,054	
278,130,045	270,730,045	260,402,459	70,371,572	
275,688,409	268,288,409	257,940,168	57,507,590	
273,247,040	265,847,040	255,478,103	41,255,764	
270,805,941	263,405,941	253,016,266	24,949,807	
268,365,109	260,965,109	250,554,655	8,589,558	
265,924,548	258,524,548	248,093,272	(7,825,145)	
263,484,256	256,084,256	245,632,118	(24,294,465)	
261,044,234	253,644,234	243,171,192	(40,818,566)	
258,604,484	251,204,484	240,710,496	(57,397,610)	
256,165,005	248,765,005	238,250,029	(74,031,763)	
253,725,798	246,325,798	235,789,792	(90,721,187)	
251,286,864	243,886,864	233,329,786	(107,466,049)	

Modeling of new and existing building square footage by building type

Year	increment	Existing residential sc	New Res SqFt	SqFt affected by ReskWh/SqFt	ReskWh/SqFt
2018		130,000,000	0		14.6
2019		130,260,000	0		14.6
2020		130,520,520	0		14.6
2021		130,781,561	-		14.6
2022	1	131,043,124	-	1,310,431	14.6
2023	2	131,043,124	262,086	2,882,949	14.6
2024	3	131,043,124	524,697	4,455,990	14.6
2025	4	131,043,124	787,832	6,029,557	14.6
2026	5	131,043,124	1,051,494	7,603,650	14.6
2027	6	131,043,124	1,315,683	9,178,271	14.6
2028	7	131,043,124	1,580,401	10,753,420	14.6
2029	8	131,043,124	1,845,648	12,329,098	14.6
2030	9	131,043,124	2,111,426	13,905,307	14.6
2031	10	131,043,124	2,377,735	15,482,047	14.6
2032	11	131,043,124	2,644,576	17,059,320	14.6
2033	12	131,043,124	2,911,952	18,637,127	14.6
2034	13	131,043,124	3,179,862	20,215,468	14.6
2035	14	131,043,124	3,448,308	21,794,345	14.6
2036	15	131,043,124	3,717,291	23,373,760	14.6
2037	16	131,043,124	3,986,812	24,953,712	14.6
2038	17	131,043,124	4,256,872	26,534,203	14.6
2039	18	131,043,124	4,527,472	28,115,234	14.6
2040	19	131,043,124	4,798,613	29,696,806	14.6
2041	20	131,043,124	5,070,296	31,278,921	14.6
2042	21	131,043,124	5,342,523	32,861,579	14.6
2043	22	131,043,124	5,615,294	34,444,782	14.6
2044	23	131,043,124	5,888,611	36,028,530	14.6
2045	24	131,043,124	6,162,475	37,612,824	14.6
2046	25	131,043,124	6,436,886	39,197,667	14.6
2047	26	131,043,124	6,711,846	40,783,058	14.6
2048	27	131,043,124	6,987,356	42,368,999	14.6
2049	28	131,043,124	7,263,417	43,955,492	14.6
2050	29	131,043,124	7,540,030	45,542,536	14.6

NewReskWh/SqFt	ResThm/SqFt	NewResThm/Sqft	Residential Electrific	ExstCom SqFt	NewCom SqFt
14.6	1.75	1.75	0.00	174,920,061	0
14.6	1.75	1.75	0.00	175,269,901	0
14.6	1.75	1.75	0.00	175,620,441	0
14.6	1.75	1.75	0.00	175,971,682	0
14.6	1.75	1.75	0.00	176,323,625	0
14.6	1.75	1.75	0.00	176,323,625	352,647
14.6	1.75	1.75	0.00	176,323,625	706,000
14.6	1.75	1.75	0.00	176,323,625	1,060,059
14.6	1.75	1.75	0.06	176,323,625	1,414,826
14.6	1.75	1.75	0.12	176,323,625	1,770,303
14.6	1.75	1.75	0.18	176,323,625	2,126,491
14.6	1.75	1.75	0.24	176,323,625	2,483,391
14.6	1.75	1.75	0.30	176,323,625	2,841,005
14.6	1.75	1.75	0.33	176,323,625	3,199,335
14.6	1.75	1.75	0.36	176,323,625	3,558,381
14.6	1.75	1.75	0.39	176,323,625	3,918,145
14.6	1.75	1.75	0.42	176,323,625	4,278,628
14.6	1.75	1.75	0.45	176,323,625	4,639,833
14.6	1.75	1.75	0.48	176,323,625	5,001,760
14.6	1.75	1.75	0.51	176,323,625	5,364,410
14.6	1.75	1.75	0.54	176,323,625	5,727,786
14.6	1.75	1.75	0.57	176,323,625	6,091,889
14.6	1.75	1.75	0.60	176,323,625	6,456,720
14.6	1.75	1.75	0.64	176,323,625	6,822,281
14.6	1.75	1.75	0.68	176,323,625	7,188,573
14.6	1.75	1.75	0.72	176,323,625	7,555,597
14.6	1.75	1.75	0.76	176,323,625	7,923,356
14.6	1.75	1.75	0.80	176,323,625	8,291,850
14.6	1.75	1.75	0.84	176,323,625	8,661,081
14.6	1.75	1.75	0.88	176,323,625	9,031,050
14.6	1.75	1.75	0.92	176,323,625	9,401,759
14.6	1.75	1.75	0.96	176,323,625	9,773,210
14.6	1.75	1.75	1.00	176,323,625	10,145,404

Com SqFt build	ComkWh/SqFt	NewComkWh/¢	ComThm/SqFt	NewComThm/¢	Commercial Electr
	14.3	14.3	0.52	0.52	0.00
	14.3	14.3	0.52	0.52	0.00
	14.3	14.3	0.52	0.52	0.00
	14.3	14.3	0.52	0.52	0.00
1,763,236	14.3	14.3	0.52	0.52	0.00
3,879,120	14.3	14.3	0.52	0.52	0.00
5,995,709	14.3	14.3	0.52	0.52	0.00
8,113,004	14.3	14.3	0.52	0.52	0.00
10,231,008	14.3	14.3	0.52	0.52	0.02
12,349,721	14.3	14.3	0.52	0.52	0.04
14,469,145	14.3	14.3	0.52	0.52	0.06
16,589,281	14.3	14.3	0.52	0.52	0.08
18,710,132	14.3	14.3	0.52	0.52	0.10
20,831,697	14.3	14.3	0.52	0.52	0.13
22,953,979	14.3	14.3	0.52	0.52	0.16
25,076,980	14.3	14.3	0.52	0.52	0.19
27,200,699	14.3	14.3	0.52	0.52	0.22
29,325,140	14.3	14.3	0.52	0.52	0.25
31,450,303	14.3	14.3	0.52	0.52	0.28
33,576,190	14.3	14.3	0.52	0.52	0.31
35,702,803	14.3	14.3	0.52	0.52	0.34
37,830,142	14.3	14.3	0.52	0.52	0.37
39,958,209	14.3	14.3	0.52	0.52	0.40
42,087,006	14.3	14.3	0.52	0.52	0.43
44,216,534	14.3	14.3	0.52	0.52	0.46
46,346,795	14.3	14.3	0.52	0.52	0.49
48,477,789	14.3	14.3	0.52	0.52	0.52
50,609,520	14.3	14.3	0.52	0.52	0.55
52,741,987	14.3	14.3	0.52	0.52	0.58
54,875,192	14.3	14.3	0.52	0.52	0.61
57,009,138	14.3	14.3	0.52	0.52	0.64
59,143,825	14.3	14.3	0.52	0.52	0.67
61,279,255	14.3	14.3	0.52	0.52	0.70

Electric percentage projections

Starting new car sales	29,500
Starting Evs	2,212.50
Starting LDV total	442,500

Additional data

EV new car percentages 2019 through 2050

LDV

EV Sales projections

growth in new car sales based on population growth

Year	New Car sales	new car % EV	New EV
2018	29,825	0.78	233
2019	29,884	3.0	911
2020	29,944	5.3	1593
2021	30,004	7.6	2277
2022	30,064	9.9	2964
2023	30,124	12.1	3653
2024	30,184	14.4	4346
2025	30,245	17	5041
2026	30,305	23	7071
2027	30,366	30	9110
2028	30,426	37	11156
2029	30,487	43	13211
2030	30,548	50	15274
2031	30,609	54	16529
2032	30,671	58	17789
2033	30,732	62	19054
2034	30,793	66	20324
2035	30,855	70	21598
2036	30,917	74	22878
2037	30,978	78	24163
2038	31,040	82	25453
2039	31,103	86	26748
2040	31,165	90	28048
2041	31,227	91	28417
2042	31,289	92	28786
2043	31,352	93	29157
2044	31,415	94	29530
2045	31,478	95	29904
2046	31,541	96	30279
2047	31,604	97	30656
2048	31,667	98	31034
2049	31,730	99	31413
2050	31,794	100	31794

Average lifetime	15.0	
	6.7%	annual percent turnover

heavy duty sales
<https://www.mcl>

025 based on <https://evadoption.com/ev-sales/ev-sales-forecasts/>

Heavy duty
 initial total vehicles indexed to 100

Total EV	Total cars	EV percent of total	new vehicles	EV % of new
2213	442,500	0.50%	6.7	0.0
3124	443,385	0.70%	6.7	2.5
4717	444,272	1.06%	6.7	5.0
6993	445,160	1.57%	6.7	7.5
9957	446,051	2.23%	6.7	10.0
13610	446,943	3.05%	6.7	12.5
17956	447,837	4.01%	6.7	15.0
22997	448,732	5.12%	6.8	17.5
30068	449,630	6.69%	6.8	20.0
39178	450,529	8.70%	6.8	22.5
50334	451,430	11.15%	6.8	25.0
63545	452,333	14.05%	6.8	27.5
78819	453,238	17.39%	6.8	30.0
95348	454,144	21.00%	6.8	35.0
113137	455,052	24.86%	6.9	40.0
129979	455,962	28.51%	6.9	45.0
150069	456,874	32.85%	6.9	50.0
170757	457,788	37.30%	6.9	55.0
192042	458,704	41.87%	6.9	60.0
213929	459,621	46.54%	6.9	65.0
236418	460,540	51.33%	6.9	70.0
259513	461,461	56.24%	7.0	75.0
283215	462,384	61.25%	7.0	80.0
306591	463,309	66.17%	7.0	83.0
328306	464,236	70.72%	7.0	86.0
348354	465,164	74.89%	7.0	89.0
366728	466,095	78.68%	7.0	92.0
383420	467,027	82.10%	7.0	95.0
398425	467,961	85.14%	7.1	98.0
412552	468,897	87.98%	7.1	101.0
425796	469,835	90.63%	7.1	104.0
438155	470,774	93.07%	7.1	107.0
449625	471,716	95.32%	7.1	100.0

assumptions based off and extended from

kinsey.com/industries/automotive-and-assembly/our-insights/whats-sparking-electric-vehicle-adopti

new EV	Total EV	total vehicles	EV % of total
0.0	0.0	100	0%
0.2	0.2	100	0%
0.3	0.5	100	0%
0.5	1.0	101	1%
0.7	1.7	101	2%
0.8	2.5	101	2%
1.0	3.5	101	3%
1.2	4.7	101	5%
1.4	6.1	102	6%
1.5	7.6	102	7%
1.7	9.3	102	9%
1.9	11.2	102	11%
2.0	13.2	102	13%
2.4	15.6	103	15%
2.7	18.4	103	18%
3.1	21.4	103	21%
3.4	25	103	24%
3.8	29	103	28%
4.1	32	104	31%
4.5	36	104	35%
4.9	41	104	39%
5.2	45	104	43%
5.6	49	104	47%
5.8	54	105	52%
6.0	59	105	56%
6.2	63	105	60%
6.5	68	105	65%
6.7	73	106	69%
6.9	78	106	74%
7.1	83	106	78%
7.4	87	106	82%
7.6	92	106	86%
7.1	95	107	89%



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Start VMT BAU % annual population growth Heavy duty vehicle VMT annual growth
 2,807,553,060 0.2% 0.2%

Year	Light duty vehicles			
	BAU VMT	VMT reduction	EV + VMT reduction	
			Gasoline VMT	EV VMT
2018	2,807,553,060	2,807,553,060	2,793,515,295	14,037,765
2019	2,813,168,166	2,813,168,166	2,793,348,274	19,819,892
2020	2,818,794,502	2,818,794,502	2,788,869,125	29,925,378
2021	2,824,432,091	2,766,969,491	2,723,500,729	43,468,762
2022	2,830,080,956	2,715,144,481	2,654,534,635	60,609,845
2023	2,835,741,118	2,663,319,470	2,582,215,162	81,104,307
2024	2,841,412,600	2,611,494,459	2,506,785,987	104,708,471
2025	2,847,095,425	2,559,669,448	2,428,490,143	131,179,304
2026	2,852,789,616	2,507,844,437	2,340,137,588	167,706,848
2027	2,858,495,195	2,456,019,426	2,242,445,380	213,574,045
2028	2,864,212,185	2,404,194,415	2,136,128,685	268,065,730
2029	2,869,940,610	2,352,369,404	2,021,900,779	330,468,625
2030	2,875,680,491	2,300,544,393	1,900,473,057	400,071,336
2031	2,881,431,852	2,275,849,968	1,798,031,203	477,818,766
2032	2,887,194,716	2,251,155,543	1,691,462,625	559,692,918
2033	2,892,969,105	2,226,461,119	1,591,777,005	634,684,114
2034	2,898,755,043	2,201,766,694	1,478,552,562	723,214,132
2035	2,904,552,553	2,177,072,269	1,365,016,518	812,055,751
2036	2,910,361,659	2,152,377,844	1,251,257,270	901,120,575
2037	2,916,182,382	2,127,683,420	1,137,362,985	990,320,435
2038	2,922,014,747	2,102,988,995	1,023,421,599	1,079,567,396
2039	2,927,858,776	2,078,294,570	909,520,816	1,168,773,755
2040	2,933,714,494	2,053,600,146	795,748,110	1,257,852,035
2041	2,939,581,923	2,057,744,509	696,048,119	1,361,696,389
2042	2,945,461,087	2,061,888,871	603,726,225	1,458,162,647
2043	2,951,352,009	2,066,033,234	518,813,805	1,547,219,429
2044	2,957,254,713	2,070,177,597	441,342,144	1,628,835,453
2045	2,963,169,222	2,074,321,960	371,342,432	1,702,979,528
2046	2,969,095,561	2,078,466,323	308,845,766	1,769,620,557
2047	2,975,033,752	2,082,610,686	250,257,772	1,832,352,914
2048	2,980,983,819	2,086,755,049	195,594,970	1,891,160,079
2049	2,986,945,787	2,090,899,412	144,873,829	1,946,025,583
2050	2,992,919,678	2,095,043,775	98,110,767	1,996,933,008

Heavy duty vehicles			
BAU VMT	EV + VMT reduction		EV VMT
	Diesel/Gasoline VMT		
311,950,340	311,950,340		-
312,574,241	312,053,284		520,957
313,199,389	311,634,434		1,564,955
313,825,788	310,691,704		3,134,084
314,453,440	309,222,999		5,230,440
315,082,346	307,226,220		7,856,126
315,712,511	304,699,260		11,013,252
316,343,936	301,640,005		14,703,931
316,976,624	298,046,338		18,930,286
317,610,577	293,916,133		23,694,444
318,245,798	289,247,257		28,998,541
318,882,290	284,037,574		34,844,716
319,520,055	278,284,937		41,235,118
320,159,095	271,453,598		48,705,496
320,799,413	263,539,265		57,260,147
321,441,012	254,537,634		66,903,378
322,083,894	244,444,386		77,639,508
322,728,061	233,776,149		88,951,913
323,373,518	222,530,662		100,842,855
324,020,265	210,705,660		113,314,605
324,668,305	198,298,869		126,369,436
325,317,642	185,308,010		140,009,632
325,968,277	171,730,796		154,237,482
326,620,214	158,000,426		168,619,787
327,273,454	144,116,344		183,157,110
327,928,001	130,077,988		197,850,013
328,583,857	115,884,797		212,699,060
329,241,025	101,536,209		227,704,816
329,899,507	87,031,657		242,867,849
330,559,306	72,904,175		257,655,130
331,220,424	59,155,329		272,065,095
331,882,865	45,786,689		286,096,176
332,546,631	35,016,809		297,529,822

Light duty vehicles

Start VMT Start MTCO2e MTCO2e/mile
 2,807,553,060 1,159,950 0.000413153

Heavy duty vehicles

Start VMT
 311,950,340

Year	Indexed CO2e/mile	MTCO2e/mile	Indexed efficiency
2018	1	0.0004132	1
2019	0.99	0.0004083	1.00
2020	0.98	0.0004035	1.00
2021	0.97	0.0003987	1.00
2022	0.95	0.0003939	1.00
2023	0.94	0.0003891	1.00
2024	0.93	0.0003842	1.00
2025	0.92	0.0003794	1.00
2026	0.91	0.0003746	1.00
2027	0.90	0.0003698	1.00
2028	0.88	0.0003650	1.00
2029	0.87	0.0003601	1.00
2030	0.86	0.0003553	100%
2031	0.85	0.0003516	1.00
2032	0.84	0.0003479	1.00
2033	0.83	0.0003442	1.00
2034	0.82	0.0003404	1.00
2035	0.82	0.0003367	1.00
2036	0.81	0.0003330	1.00
2037	0.80	0.0003293	1.00
2038	0.79	0.0003256	1.00
2039	0.78	0.0003218	1.00
2040	0.77	0.0003181	1.00
2041	0.77	0.0003181	1.00
2042	0.77	0.0003181	1.00
2043	0.77	0.0003181	1.00
2044	0.77	0.0003181	1.00
2045	0.77	0.0003181	1.00
2046	0.77	0.0003181	1.00
2047	0.77	0.0003181	1.00
2048	0.77	0.0003181	1.00
2049	0.77	0.0003181	1.00
2050	0.77	0.0003181	1.00

Fuel source	Value	Unit
Renewables	3,412	BTU per kWh
Hydro	3,412	BTU per kWh
Nuclear	10,459	BTU per kWh
Natural gas	7,907	BTU per kWh
Coal	10,428	BTU per kWh

Source

U.S. EIA Annual Energy Review 2016, Table 8.1

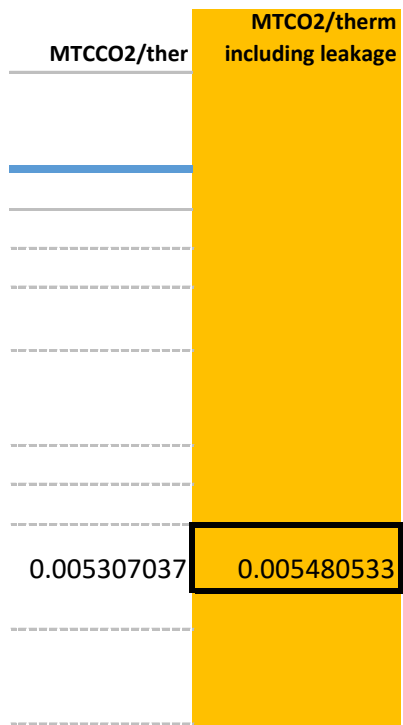
<http://www.eia.gov/electricity/annual/html/>

Carbon Dioxide Emissions Coefficients by Fuel

Carbon Dioxide (CO2) Factors:	Pounds CO2	Kilograms CO2	Pounds CO2	Kilograms CO2
	Per Unit of Volume or Mass	Per Unit of Volume or Mass	Per Million Btu	Per Million Btu
For homes and businesses				
Propane	12.70 gallon	5.76 gallon	139.05	63.07
Butane	14.80 gallon	6.71 gallon	143.20	64.95
Butane/Propane Mix	13.70 gallon	6.21 gallon	141.12	64.01
Home Heating and Diesel Fuel (Distillate)	22.40 gallon	10.16 gallon	161.30	73.16
Kerosene	21.50 gallon	9.75 gallon	159.40	72.30
Coal (All types)	4,631.50 short ton	2,100.82 short ton thousand	210.20	95.35
Natural Gas	117.10 thousand cubic feet	53.12 cubic feet	117.00	53.07
Gasoline	19.60 gallon	8.89 gallon	157.20	71.30
Residual Heating Fuel (Businesses only)	26.00 gallon	11.79 gallon	173.70	78.79

1: Average operating heat rate for selected energy sources

[epa_08_01.html](#)



PV production

1532 kWh/kW capacity From PVWatts tool, 1 axis tracking, all other settings defa

Energy needs

5,347,234,687 Current electricity demand

501,758,270 current natural gas use

5,017,582,700 electricity to replace natural gas use

2,807,553,060 light duty VMT

842,265,918 electricity needed for light duty 100% EV

311,950,340 heavy duty VMT

623,900,680 electricity needed for heavy duty 100% EV

11,830,983,985 total kWh needed

7,723 MW PV capacity to supply total usage

56,632 acres needed

88 square miles needed

9.4 miles - one side of square installation if all in one place

0.58% of Wisconsin agricultural land

ult

PV area - Badger hollow example

300 MW capacity

2200 acres

733.3333 acres for 100 MW

0.136364 MW/acre

9,762,700 Total agricultural land area in wisconsin

